EX PARTE OR LATE FILED

RECEIVED

JAN - 5 1994

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

DOCKET FILE COPY ORIGINAL

THE LAW OFFICES OF
MICHAEL R. GARDNER, P.C.
ATTORNEYS AT LAW
1150 CONNECTICUT AVENUE, N.W.
SUITE 710
WASHINGTON, D.C. 20036
(202) 785-2828
FAX (202) 785-1504

January 5, 1994

By Hand

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, NW
Washington, DC 20554

Re: CC Docket No. 92-297
Local Multipoint Distribution Service

Dear Mr. Caton:

On behalf of Suite 12 Group ("Suite 12"), petitioner in the above-referenced rulemaking proceeding, enclosed please an original and five (5) copies of a Reply submitted in response to "Supplemental Comments" filed by Motorola Satellite Communications, Inc. ("Motorola") in the above-referenced proceeding. Suite 12's Reply includes a technical study, titled "LMDS Cannot Interfere with Motorola Iridium (LEO)," which was jointly prepared by Eric N. Barnhart, Chief, Communications and Networking Division, Information Technology and Telecommunications Laboratory, Georgia Institute of Technology, Roger L. Freeman, Roger Freeman Associates and Suite 12 inventor-engineer Bernard B. Bossard. This study demonstrates that the Local Multipoint Distribution Service ("LMDS") cannot interfere with the Motorola Iridium low earth orbit satellite system, and identifies a number of flawed assumptions and miscalculations which led to Motorola's erroneous conclusion that LMDS would interfere with Iridium.

Please direct any questions regarding this matter to the undersigned.

Sincerely,

Michael R. Gardner

Michael R. Gardner
Charles R. Milkis
William J. Gildea III
Counsel for Suite 12 Group

Enclosure
cc Attached service list

No. of Copies rec'd 0+5
List ABCDE

RECEIVED

JAN - 5 1994

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

DOCKET FILE COPY ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matters of	
Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules and Policies for Local Multipoint Distribution Service;	CC Docket No. 92-297 RM-7872; RM-7722
Applications for Waiver of the Commission's Common Carrier Point-to-Point Microwave Radio Service Rules;	
Suite 12 Group Petition for Pioneer's Preference;	PP-22
University of Texas - Pan American Petition for Reconsideration of Pioneer's Preference Request Denial	

To: The Commission

REPLY OF SUITE 12 GROUP TO MOTOROLA SATELLITE COMMUNICATIONS, INC.'s "SUPPLEMENTAL COMMENTS"

Suite 12 Group ("Suite 12"), by its attorneys, hereby files a Reply to Motorola Satellite Communications, Inc.'s ("Motorola") "Supplemental Comments" dated November 22, 1993 which Motorola has sought to file in the above-captioned proceeding.

Notwithstanding the grossly untimely nature of Motorola's "Supplemental Comments," the submission of which Suite 12 challenged on procedural grounds in an Opposition filed on December 2, 1993,[1] Motorola's erroneous assertion therein that the Local Multipoint Distribution Service ("LMDS") will interfere with Motorola's Iridium low earth orbit satellite system ("Iridium") compels Suite 12 to respond to ensure that the record in this proceeding is accurate.

Accordingly, attached is a technical study, titled "LMDS Cannot Interfere with Motorola Iridium (LEO)," which was prepared jointly by Eric N. Barnhart, Chief, Communications and Networking Division, Information Technology and Telecommunications Laboratory, Georgia Institute of Technology, Roger L. Freeman, Roger Freeman Associates and Suite 12 inventor-engineer Bernard B. Bossard. This study identifies the numerous errors and flawed assumptions made by Motorola in its interference calculations, and concludes that LMDS cannot interfere with Iridium. Specifically, this study demonstrates that the Interference to Noise ratio ("I/N") of a worst-case LMDS signal into an Iridium receiver will be approximately -35 dB, well within the self-serving, excessive and unsupported I/N of -19 dB which Motorola claims it requires.[2]

Accordingly, in view of the fact that LMDS will not cause harmful

[1] As Suite 12 noted, Motorola failed to explain why it had waited more than seven months to file "Supplemental Comments" purportedly in response to Suite 12's April 15, 1993 Reply Comments. As Suite 12 argued, consistent with Commission precedent, Motorola's Motion for Leave should be denied, and its untimely "Supplemental Comments" should not be formally considered in this proceeding. See Amendment of the Commission's Rules to Establish New Personal Communications Services, Order (DA 93-1055), released August 30, 1993.

[2] For no apparent reason, Motorola specifies a required I/N of -19 dB, which is 9 dB greater than both the CCIR and NASA recommendations.

interference to Motorola's Iridium system, Motorola's misplaced request for a set aside for Fixed Satellite Services in the 29.1-29.3 GHz band is unnecessary and should be rejected.

Respectfully submitted,

Suite 12 Group

By: Michael R. Gardner

Michael R. Gardner
Charles R. Milkis
William J. Gildea III

THE LAW OFFICES OF
MICHAEL R. GARDNER, P.C.
1150 Connecticut Ave., NW
Suite 710
Washington, DC 20036
(202) 785-2828

Its Attorneys

January 5, 1994

LMDS CANNOT INTERFERE WITH MOTOROLA IRIDIUM (LEO)

by

• ***Eric N. Barnhart*** •
Chief, Communications and Networking Division
Information Technology & Telecommunications Laboratory
Georgia Institute of Technology

• ***Roger L. Freeman*** •
Roger Freeman Associates

• ***Bernard B. Bossard*** •
Suite 12 Inventor-Engineer

LMDS CANNOT INTERFERE WITH MOTOROLA IRIDIUM (LEO)

The purpose of this paper is to reaffirm that the total worst case LMDS composite interfering signal into an IRIDIUM (LEO) satellite receiver at a 10-degree elevation angle results in an interference-to-noise ratio (I_o/N_o) of better than -35 dB, even using Motorola Satellite Communication, Inc.'s ("Motorola") own assumptions contained in two of its filings in the LMDS rulemaking proceeding Comments, filed March 16, 1993, and Motion of Motorola Satellite Communications, Inc. for Leave to File Supplemental Comments, and Supplemental Comments ("Motion"), dated November 22, 1993.

This paper is divided into three sections, with six supporting appendices.

1) General Comments

2) Corrections to Motorola Calculations

3) Actual Link Budget Calculations

Appendix 1 - Motorola Uplink Calculations

Appendix 2 - LMDS Transmitting Antenna Pattern

Appendix 3 - Polarization Isolation

Appendix 4 - Coverage Areas

Appendix 5 - FM Peaking Factor

Appendix 6 - Motorola Inconsistencies

1. GENERAL COMMENTS

A) It is not clear why Motorola requires an Interference-to-Noise Ratio of -19 dB, which is 9 dB greater than NASA's requirements (See Ref. 1) and CCIR recommendations. This is particularly true when the E_b/N_o at an IRIDIUM satellite is approximately 40 dB (See Appendix 1); hence the total Motorola-recommended LMDS signal would be 59 dB below the desired (40 dB + 19 dB). This results in a desired signal which is 794 thousand times greater than the interfering signal. In spite of Motorola's apparent over-specification of the necessary protection ratio, it will be shown in this paper that the **actual** interfering signal from all LMDS sources will be almost 75 dB below the desired signal (40 dB + 35 dB), or 31 million times lower than the desired signal received by the satellite.

B) The low elevation angle of 10° results in large amounts of attenuation due to rainfall. Since LMDS, for a 99.9% time availability, has a 4.6 dB attenuation per mile, it is not inconceivable that the IRIDIUM path loss at the low angle to horizon could receive rainfall attenuation greater than 50 dB. Hence, it should be obvious that higher acquisition angles are anticipated. These higher elevation angles will, therefore, further reduce the area of coverage. Also, as indicated in Appendix 4, the earth coverage area is long (approximately 732 miles) and narrow (approximately 125 miles) which would definitely encounter consideration for reduction of LMDS cells due to the population density factor.

C) Motorola has failed to recognize that as the IRIDIUM footprint is rotated, only the LMDS emitters in the new footprint area contribute to the aggregate interference signal, not the emitters in the area now shadowed due to the footprint rotation. Thus, in a typical case, the composite LMDS interference signal would be smaller than that associated with the low acquisition angle.

D) Motorola states that the IRIDIUM gateways must be located in metropolitan areas so that they can be close to PSTN switching centers. Since these gateways do not interfere with LMDS emitters, it is not important to LMDS operation where they are placed. It would seem more appropriate to locate these IRIDIUM gateways in suburban or rural areas. Motorola states that such gateways require

360° azimuth coverage and elevation coverage down to 10° for the entire azimuth coverage. The 10° elevation coverage requires Fresnel zone and earth bulge clearance as well as radiation hazard considerations. In an urban area, gateways must be mounted on very high facilities for proper 360° clearance. For example, to meet these requirements in New York City, a gateway would have to be located on top of the World Trade Center or a similar tall building. It is doubtful that an interexchange carrier switching center is indeed located in this type of complex. For example, the AT&T international switching center is in White Plains, located about 20 miles to the north in a suburban area. Accordingly, Motorola's argument that its gateways <u>must</u> be located in urban areas near InterLata carrier switching centers lacks credibility due to the unavailability of sites meeting field of view criteria, radiation hazard conditions and proximity to switching centers. Hence, some form of point-to-point communication link, cable or microwave, will be established between a Motorola gateway and the switching center. Motorola could well benefit from locating its gateways in the numerous low population density areas which surround major cities.

E) Motorola states in paragraph 2.2 of the Technical Appendix of its Motion that "The LMDS proponents suggest their antennas would have a 10-13 dB gain with a uniform pattern in the azimuth direction. — These directivities translate to half-power beamwidths of 57 to 40 degrees." Actually, it is impossible to construct any antenna with 360° azimuth coverage and a 50° elevation coverage with a corresponding gain of +10 dBi. It is possible to construct an antenna with a 50° azimuth and a 50° elevation coverage, but it is of little value for LMDS applications. The error which Motorola has made in LMDS transmitting antenna gain has dreadfully fouled their conclusions. Appendix 2 of this report shows typical radiation pattern characteristics of the LMDS transmitting antenna. It should be realized that even without the LMDS antenna pattern isolation, the total interference of LMDS to the satellite is substantially below the noise level of the satellite receiver.

F) In its Motion, in section A.4, Motorola states that the mainbeam interference area includes over 7550 possible LMDS transmission sites. However, Motorola has not taken into account the common demographic statistics for the United States. In fact, one reference source demonstrates that 75% of the population lives in 2.5% of the total U.S. land area. (Reference: Bureau of the Census, U.S. Department of Commerce News, Dec., 18, 1991, Table 1). It can be estimated that 90% of the population lives in a 10% of the land area of CONUS. (Reference: Rand McNally "1994 Commercial Atlas & Marketing Guide," 125th ed.). This 90%/10% value results in a -10 dB for a population distribution correction factor. This should be considered a conservative estimate, since the ellipse of the Iridium footprint is rather long (732 miles) and narrow (125 miles).

2. CORRECTIONS TO MOTOROLA CALCULATIONS

In this section specific corrections to errors in Motorola's calculations are delineated. Use of these corrections, as will be shown in Section 3, leads to an I_o/N_o of better than -30 dB for the LMDS interference into an IRIDIUM satellite for the worst-case elevation angle. This assumes fully operational LMDS systems throughout the region of interest, including frequency interleaving of diagonal cells and reverse polarization in adjacent cells. These techniques are at no added cost to the LMDS operator and provide high-quality video service, excellent BER performance, and intrinsic isolation between LMDS operators in addition to negligible interference into any satellite in any orbit. Furthermore, these same techniques are utilized to assure an LMDS operator of the ability to reuse the same frequency in all adjacent cells, thereby optimizing spectral efficiency—this is unlike any other point to multipoint system.

Many errors have been noted in the referenced Motorola submissions to the FCC. These are shown in Table 1.

TABLE 1. Errors in Motorola Documentation

Motorla Ref.	Item	Motorola	LMDS	Error	Our Reference
Sect. 2.2	Hub antenna gain	+10.5 dBi	-15 dBi	25.5 dB	Appn 2
Tbl 2	LMDS EIRP	-63.9 dBW/ Hz	-92.4 dBW/Hz	28.5 dB	Table 5 Col.1 vs. Col.2
Tbl 4	Polarization	-3 dB	-3 dB	0 dB	Appn 3
Sect.3.2	Number of LMDS stations	3000	2553	0.7 dB	Appn 4
—	Population density	0 dB uniform distrib.	- 10 dB nonuni-form distrib	10 dB	Text above
TOTAL ERROR	——	——	——	39.2 dB	See statement below.

The total error includes a combination of LMDS EIRP, polarization, number of LMDS stations, and population density (28.5 + 0 + 0.7 + 10 = 39.2 dB).

There are other errors in the Motorola Analysis. For example, in its Motion, Table 4, LEO Received Power Spectral Density ("PSD") Iob =-227.4 dBW/Hz. However, when this value is substituted in the term Iob+N in Section 3.2 of the Motorola report, the Iob value was transposed to -224.7, further favoring Motorola's argument by 2.7 dB.

Motorola also appears to have gerrymandered other figures such as LEO/IRIDIUM gateway EIRP. In Motorola's March 16th Comments, the EIRP would be +68.3 dBW (page 3, Technical Appendix where transmitter peak power is +12 dBW and the antenna gain is +56.3 dBi). However, in its November 22nd Motion, Motorola uses an EIRP of +43.2 dBW (See Table 3 of the Technical Appendix). This inconsistency is extremely significant since the less EIRP, the more degraded the interference ratio to the desired signal. Hence there is a major additional error of 25.1 dB (the difference between 68.3 dB - 43.2 dB) in Motorola's November 22nd Motion.

Further, in the Motorola Motion, in the Technical Appendix, Section 3.1, Motorola states that "Since the LEO system design is based on a protection ratio of 16 dB for all sources, the protection ratio for LMDS alone should be 19 dB (half the total interference)." Both NASA, in its submissions to the FCC in the LMDS rulemaking proceeding, and CCIR recommendations, state that only a 10 dB protection ratio is required. As a result, for no apparent reason, Motorola burdens LMDS with an additional 9 dB of protection ratio.

Finally, if we sum all the errors in Motorola's two submissions to the FCC, the result is 39.2 dB from Table 1, 2.7 dB lob value, 25.1 dB EIRP and 9 dB protection ratio, for a total error of 75.3 dB.

In addition, Motorola states in its Motion (Section 3.2, Technical Appendix) that there could be a maximum of only 5 LMDS stations before causing unacceptable interference. On the other hand, we demonstrate herein that even with a 10-degree elevation angle, there is an IRIDIUM G/T footprint of 72,260 square miles. With an LMDS cell size of 28.3 square miles for the New York area, we calculate the number of cells (i.e., LMDS emitters) to be 2,556 (72,260/28.3), compared to an acceptable maximum number of LMDS calculated by Motorola of 5. Hence, LMDS has 2551 (i.e., 2556-5) more transmitters in the footprint than allowed by Motorola. Hence, we need a correction in Motorola's favor. This correction is 10Log2551, or 34.1 dB, which is used to reduce the above Motorola error from 75.3 dB to 41.2 dB (75.3 dB - 41.2 dB).

3. ACTUAL LINK BUDGET CALCULATIONS

LMDS interference calculations are presented in Table 2 and its continuation in Tables 3, 4, 5 and 6. There are two columns: the Motorola Model and the Correct Model. Motorola's errors in presentation and calculation are patently apparent.

TABLE 2. Link Budget Input Parameters

PARAMETER	MOTOROLA MODEL	CORRECT MODEL
Distance to LEO	2326 km	2326 km
Elevation angle	10 degrees	10 degrees
Beamwidth	5 degrees	5 degrees
Satellite ant. gain	+30.1 dBi	+30.1 dBi
LMDS TWTA max power output	+20 dBW	+20 dBW

TABLE 3. Link Budget I

PARAMETER	MOTOROLA MODEL	CORRECT MODEL
LMDS TWTA max power output	+20 dBW	+20 dBW
TWTA backoff	-7 dB	-7 dB
49 TV channel factor	-16.9 dB	-16.9 dB
Transmitter output power per channel (18 MHz bandwidth)	-3.9 dBW	-3.9 dBW

TABLE 4. Link Budget II

PARAMETER	MOTOROLA MODEL	CORRECT MODEL
Transmitter output power per channel (18 MHz bandwidth)	-3.9 dBW	-3.9 dBW
FM peak power (See our Appendix 5)	+3.0 dB	0 dB
Power spectral density (PSD) conversion ($10Log18x10^6$)	-72.55 dB	-72.55 dB
Transmitter output PSD to antenna	-73.45 dBW/Hz	-76.45 dBW/Hz

TABLE 5. Link Budget III

PARAMETER	MOTOROLA MODEL	CORRECT MODEL
Transmitter output PSD to antenna	-73.45 dBW/Hz	-76.45 dBW/Hz
Transmission line loss	-1.0 dB	-1.0 dB
LMDS hub antenna gain	+10.5 dBi	-15 dBi
Single LMDS hub EIRP PSD	-63.95 dBW/Hz	-92.45 dBW/Hz

TABLE 6. Link Budget IV

PARAMETER	MOTOROLA MODEL	CORRECT MODEL
Single LMDS hub EIRP PSD	-63.95 dBW	-92.45 dBW
Free space loss	-189.1 dB	-189.1 dB
Atmospheric gas loss	-1.5 dB	-1.5 dB
Polarization decoupling loss	-3.0 dB	-3.0 dB
Satellite antenna gain	+30.1 dBi	+30.1 dBi
Transmission line loss	—	-1.0 dB
Receive signal (interference) level, single LMDS	-227.45 dBW	-256.95 dBW

Up to this point, the Motorola error from the above Tables is 29.5 dB (-256.95 dBW + 227.45 dBW) which, when adding 10 dB for population density, results in a 39.5 dB error which is similar to that shown in Table 1.

At a 10° elevation angle, the IRIDIUM G/T contour on the earth's surface is 72,260 square miles (Appendix 4). An LMDS cell with a 3-mile radius occupies 28.3 square miles. Thus, in 72,260 square miles there are 2556 cells or LMDS emitters. When these emitters combine in space, a maximum of 34.1 dB (i.e., 10Log2556) is added to the receive signal (interference) level. However, this value must be corrected by the population density distribution (i.e., 90% of the U.S. population lives in 10% of the land area). This reduces the number of potential LMDS emitters by 10 dB, or we add 24.1 dB rather than 34.1 dB to the single LMDS receive signal (interference) level.

Considering the **Correct Model** link budget column in Tables 2 through 6, the receive signal (interference) level is:

I_o = -256.95 dBW/Hz + 24.1 dB

= -232.85 dBW/Hz

The Motorola IRIDIUM LEO satellite noise floor (N_o) is:

-228.6 dBW/Hz + 10Log1295*

N_o = -197.5 dBW/Hz

Hence,

I_o/N_o = -35.35 dB

---

* The 1295 K value for the IRIDIUM 29 GHz receiving system is taken from page 3 of the Motorola Comments, Technical Appendix.

4. CONCLUSION

Using conventional radio system analysis techniques, we have shown that the interference level due to an aggregate of LMDS emitters in the IRIDIUM G/T contour based on a 10° elevation angle is 35.3 dB below the thermal noise floor of an IRIDIUM 29 GHz receiver. This value is far in excess of the 19 dB protection parameter established by Motorola. In other words Motorola allows a 1.26% increase in the satellite receiver noise floor due to the aggregate of LMDS interference. The actual interference increase due to an aggregate of LMDS emitters in the 10-degree elevation angle contour is only 0.0295%, an unmeasurable amount. Thus, without reservation, we can say that **LMDS does not interfere with Motorola IRIDIUM**.

REFERENCES

1. "Appendix B, Sharing Between Local Multipoint Distribution Service and Other Services in the 27.5-29.5 GHz Band," ARC Professional Services Group, C^3I Systems Division (NASA Comments to the FCC), no date

Appendix 1

MOTOROLA IRIDIUM 29 GHZ UPLINK ANALYSIS

Objective

The following report shows several major points of ambiguity and contradictions in Motorola documentation which allegedly proves LMDS interference into IRIDIUM 29 GHz uplink satellite receivers.

To counter these LMDS interference claims, we analyze the Motorola 29 GHz IRIDIUM uplink based on March 16, 1993 Motorola Comments, Appendix, page 3 and then follow this by a second, contradictory analysis based on Motorola's Motion for Leave to File Supplemental Comments and Supplemental Comments dated November 22, 1993.

First Analysis - Uplink Based on Motorola March 16th Comments

We postulate the bit rate from the power density as 3 Mbps (makes the assumption of 1 bit per Hz bandwidth). Namely, EIRP +12 dBW and max. power density of -52.9 dBW/Hz (i.e., antilog[12 + 52.9]/10).

Link Budget

Transmitter power	+12 dBW		
Antenna gain	+56.3 dB		
EIRP	+68.3 dBW		
Free space loss (FSL)	-189.1 dB		(all based on 10° elev. angle)
Atmos loss	-1.5 dB		(Motorola 11/22/93)
Polar. loss (est).	-0.5 dB	(est)	(not given by Motorola)*
Pointing loss	-0.5 dB	(est)	(not given by Motorola)*
Isotropic rec. level	-123.3 dBW		
Satellite ant. gain	+30.1 dB		
Receive signal level	-93.2 dBW		
Rec. Therm. Noise level/Hz	-31.12 dB #		
Total	-124.32 dBW/K		
Boltzmann's constant	-(-228.6 dBW/K)		
C/N_o	104.28 dB/Hz		
-10Log(bit rate)	-64.77 dB		(bit rate est: 3 Mbps)
E_b/N_o	39.51 dB		

---

* Standard budgetary values used when real values are unknown. # The -31.12 dB value derives from 10Log1295, where 1295 K is the IRIDIUM satellite receiving system noise temperature. Motorola March 16, 1993, Technical Appendix, page 3.

E_b/N_o (required, est.)	13.0 dB QPSK $1X10^{-7}$ BER
Margin	**26.51 dB**

(Note: This margin approximately coincides with the excess attenuation due to rainfall value given on page 7 of the March 16th Motorola document.)

We now repeat the above link budget but use a different bit rate (12.5 Mbps) and assume a bandwidth of 4.38 MHz. The bit rate and bandwidth references are from page 7 (main document) of the March 16th Motorola Comments.

Still, certain assumptions must be made. Using a high level M-ary modulation scheme, 12.5 Mbps can be accommodated in 4.38 MHz, yet we believe with this approach, a certain modulation robustness is lost. It would appear that Motorola would opt for a simpler modulation scheme with good robustness, such as QPSK. Here a practical bit packing value would be 1.5 bits/Hz supporting 6.25 Mbps (12.5/2) per RF channel. In other words, two RF channels would accommodate the 12.5 Mbps data rate. (Note: We have no idea whether the channel is coded, the type of code, code rate, soft decision/hard decision, etc.)

The required E_b/N_o again is 13 dB which includes 2 dB modulation implementation loss (an estimate) and is based on a BER of $1X10^{-7.}$

Link Budget

Transmitter power	+12 dBW		
Antenna gain	+56.3 dB		
EIRP	+68.3 dBW		
Free space loss (FSL)	-189.1 dB		(all based on 10° elev. angle)
Atmos loss	-1.5 dB		(Motorola 11/22/93)
Polar. loss (est).	-0.5 dB	(est)	(not given by Motorola)*
Pointing loss	-0.5 dB	(est)	(not given by Motorola)*
Isotropic rec. level	-123.3 dBW		
Satellite ant. gain	+30.1 dB		
Receive signal level	-93.2 dBW		
Rec. Therm. Noise level/Hz	-31.12 dB#		
Total	-124.32 dBW/K		
Boltzmann's constant	-(-228.6 dBW/K)		
C/N_o	104.28 dB/Hz		
-10Log(bit rate)	-67.96 dB		(bit rate 6.25 Mbps)

E_b/N_o	36.32 dB	
E_b/N_o (required, est.)	13.0 dB	QPSK $1X10^{-7}$ BER
Margin	**23.32 dB**	

Second Analysis - Based on Motorola November 22nd Motion

We now attempt to run a link budget based on the Motorola document dated November 22, 1993, Technical Appendix, especially Tables 3 and 4.

LEO EIRP	+43.2 dBW	
Free space loss at 10°	-189.1 dB	
Atmos. loss	-1.5 dB	
Isotropic rec. level at sat	-147.4 dBW	
Sat. ant. gain	+30.1 dBi	(from Mar. 16th Motorola doc)
Rec. signal level	-117.3 dBW	
Thermal noise level sat	-131.1 dBW	
C/N	13.76 dB	

Thermal noise of satellite receiver is calculated as follows. It is based on the satellite receiving system noise temperature given in the March 16, 1993 Motorola document of 1295 K.

$$\text{Thermal noise (dBW)} = -228.6 \text{ dBW} + 10\text{Log}1295 + 10\text{Log}4.38\text{x}10^6$$
$$= -131.\text{dBW}$$

The bandwidth is 4.38 MHz as given as the predominant number in the November 22nd document.

Please note how unrealistic this link budget is. The C/N is very low. Being that we are not sure of the modulation type or bit rate, we are not sure of the meaning of the value. There is no apparent margin for rainfall. Further, small, but important losses have been left out of the link budget such as:

-pointing loss earth station
-polarization loss
-pointing loss satellite

These losses would eat up at least 1.5 dB of the C/N. If we were to be realistic and include these link degradations, then C/N would be 12.26 dB.

Compare this with the first analysis upper link budget, which has a C/N of 39.51 dB, which is much more realistic. Hence, using the second analysis, which Motorola imposed upon LMDS, then the Motorola rainfall attenuation of 26 dB (Page 7, Motorola Comments, March 16, 1993), when applied to a signal to noise of only 12.26 dB, would result in a desired Motorola signal of 13.74 dB below noise (C/N = 12.26 dB - 26 dB). Thus, communications would then be impossible in the rainfall characteristics used by Motorola.

The EIRP given in Table 3 of the Nov. 22nd document seems low. If we were to assume no line losses, the component parts of the EIRP are:

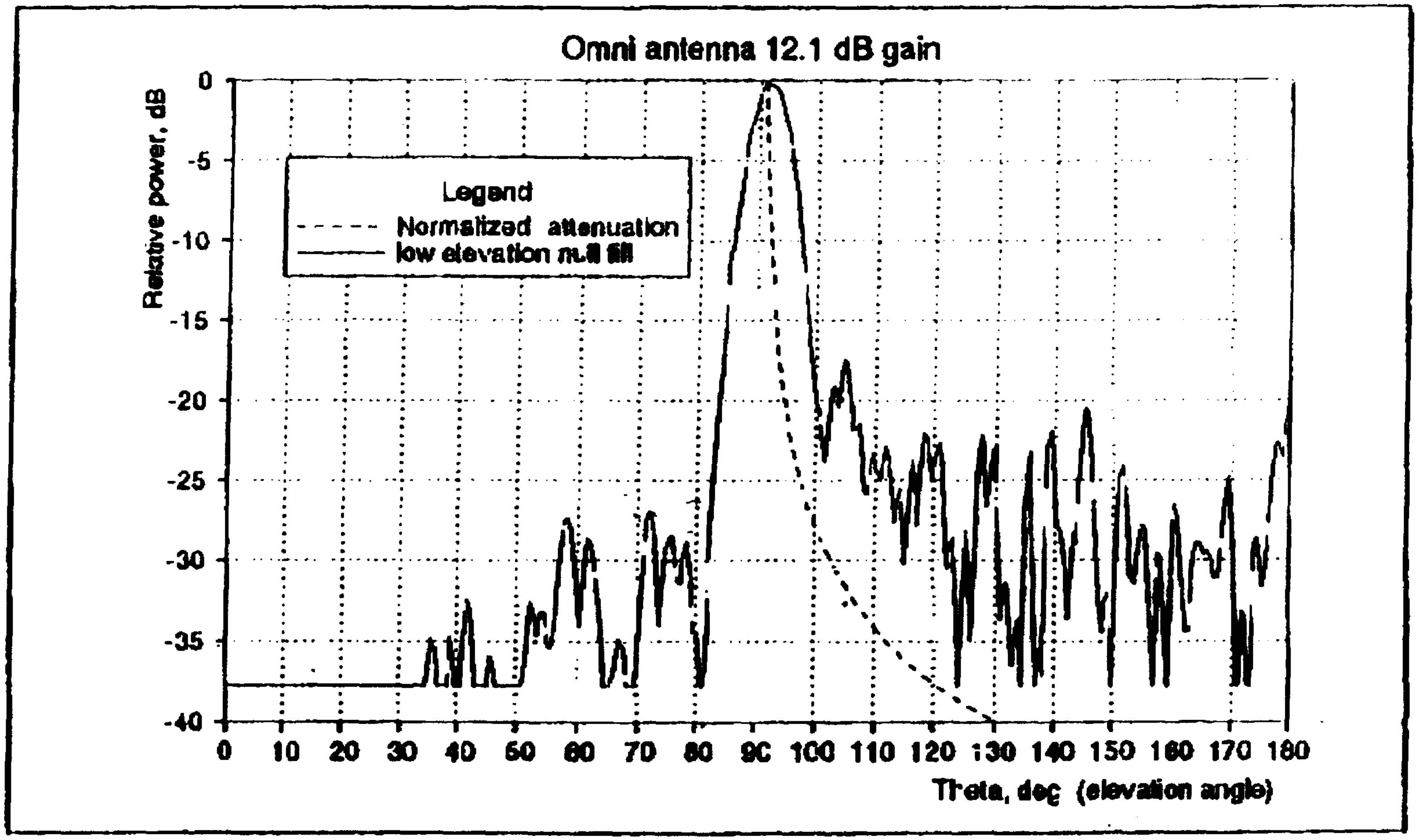
$$
\begin{aligned}
EIRP_{dBW} &= \text{Xmtr power out} + \text{antenna gain} \\
+43.2\ \text{dBW} &= \text{xmtr power out} + 56.3\ \text{dB} \\
\text{Xmtr power out} &= +43.2\ \text{dBW} - 56.3\ \text{dB} \\
&= -13.1\ \text{dBW or about } 0.05\ \text{watts}
\end{aligned}
$$

It is completely unrealistic.

It should also be noted that the March 16th Motorola document uses "Max. Power Density" value of -52.9 dBW/Hz. Deriving this from +12 dBW implies a bandwidth 3.090295 MHz and not 4.38 MHz found on page 7 of the same document. This points up still another shortcoming in the Motorola argument.

Conclusions

This brief report patently shows highly biased Motorola analyses where in each document assumptions are exaggerated and link values are inflated/deflated to allegedly attempt to demonstrate LMDS interference to IRIDIUM uplinks. One key case is EIRP. In the first Motorola document (Mar. 1993), it is +68.3 dBW; and in the second (November 1993), it is +43.2 dBW. RF bandwidths change, from 3 to 4.38 MHz. We even examined the Motorola filing (Supplemental Information. Appn A-6) and found the bandwidth was 8 MHz. Link budgets reflect a terrible lack of realism to try to prove a point. For example, the link budget based on the Motorola November 22nd Motion has no margin, does not show an allowance for modulation implementation loss, lacks allowances for other key parameters and operates at near noise such that any rain would curtail communications. It appears the parameter values are selected by Motorola just to prove their case. They are certainly not in keeping with their filing as modified by the "Supplemental Information of Feb. 1991."



Appendix 2 - LMDS transmitting antenna radiation diagram as measured on Andrew Corporation prototype.

Appendix 3

EFFECTS OF LMDS AND SATELLITE LINK POLARIZATIONS IN ASSESSMENT OF LMDS INTERFERENCE TO SATELLITE UPLINKS

This brief discussion addresses the adjustments of power into a satellite uplink receiver which should be made in interference analysis due to differences in polarization between the LMDS system and the satellite uplink in question.

When calculating the potential interference effects of multiple LMDS signal sources at the satellite uplink receiver, typical practice is to sum the power contributions of individual LMDS interferers. Given this approach, scaling factors must be applied to the analysis to account for varying incident power spectral densities, number of potential interferers, and other coupling effects such as polarization.

To treat polarization, consideration must be given to the coupling between the set of horizontally and vertically polarized LMDS signals and the satellite receiver, which may utilize linear or circular polarization. Since the LMDS sources are spatially oriented with vertical and horizontal planes relative to the earth surface and the satellite receiver may employ a different (e.g., equatorial and polar) orthogonal reference, this discussion will focus on the coupling between the LMDS signals and any linear or circular satellite polarization referenced an arbitrary pair of orthogonal planes.

Given this framework, it should be noted that if the satellite polarization is linear, then since one-half of the LMDS sources are "vertical" and one-half are "horizontal," the combined effect of the satellite discrimination against these polarizations will be to eliminate one-half of the power from the LMDS signals. This is true in both possible cases: one where the linear polarization aligns with one LMDS polarization and discriminates the other, or in the second case, which is more likely, where the satellite polarization is partially aligned with each LMDS polarization, and also discriminates against each. In either case, the reduction in power at the satellite receiver will always be 3 dB relative to the total LMDS power. Thus, for the case where the satellite employs linear polarization, the LMDS power should be reduced by a 3 dB scaling factor for interference analysis.

For the case of circular satellite polarization, we can consider the same two possibilities for relative orientation of the LMDS and satellite orthogonal planes. In the first case, in which the LMDS orthogonal planes are perfectly aligned with the orthogonal components of the receiver circular polarization, the satellite receiver antenna feed would accept both LMDS polarizations and combine them in the antenna feed/transducer, resulting in a reduction of 3 dB in LMDS power relative to the total LMDS power available at the satellite antenna. This is due to the physics of the operation of the feed in the case of circular polarization. (See Table 3.24, page 245, Morgan and Gordon, Satellite Communications Handbook, Wiley, 1989.)

For the second case, where the LMDS orthogonal planes are not aligned with the planes of the satellite polarization, the same effect results due to the vector summing of the LMDS "vertical" and "horizontal" components which are coupled into the orthogonal planes of the satellite circular polarization. Thus, in this case, the 3 dB scaling factor should be applied.

In summary, regardless of the orientation or type of polarization employed on the satellite uplink, *the power of the composite LMDS signal at the satellite receiver should be reduced by a 3 dB scaling factor in any LMDS-to-uplink interference analysis.*

APPENDIX 4 - IRIDIUM COVERAGE AREA DATA

ELEVATION ANGLE (degrees)	10	10	30	30
Beamwidth (degrees)	5	7	5	7
LENGTH (km & miles)	1,180 km (732 mi)	1,550 km (965 mi)	est.410 km (255 mi)	est.710 km (440 mi)
WIDTH (km & miles)	200 km (125 mi)	285 km (175 mi)	est.200 km (125 mi)	est.280 km (175 mi)
COVERAGE AREA (Sq. km and Sq. mi)	187,300 ±750 km^2 (72,260 ±290 mi^2)	347,400 ±1250 km^2 (134,000 ±480 mi^2)	est.65,400 ±340 km^2 (25,250 ±130 mi^2)	est. 137,000 ±1400 km^2 (52,750 ±500 mi^2)

est. = estimate

Appendix 5

CONSIDERATIONS FOR USE OF FM PEAKING FACTOR IN ASSESSMENT OF LMDS INTERFERENCE TO IRIDIUM FEEDER UPLINKS

Reference: Technical Appendix to Supplemental Comments of Motorola Satellite Communications, Inc., dated November 22, 1993

This brief discussion addresses the use of a 3 dB "FM Peaking Factor" in determining the transmitter output power spectral density to the antenna. The use of this factor appears in Section 2.1 of the above referenced appendix.

Indeed, the shape of the power spectral density (PSD) of the FM NTSC signal can be approximated as Gaussian as asserted by Motorola. Alternatively, for an FM modulation index of approximately unity, as is the case here, the spectral shape of the signal can be approximated by the shape of an AM spectrum with a suppressed carrier. Regardless of the assumption chosen, the PSD has a higher value near the carrier than near the edges of the passband of the signal.

In using the 3 dB peaking factor to compute the level of the potentially interfering LMDS signal, the author of the technical appendix assumes the worst possible case of interference level against the feeder uplink receiver for a single LMDS interference source, and then extends the worst-case result for a single LMDS interferer to the multiple LMDS sources. This approach is not correct because it ignores the fact that the collective set of potentially interfering LMDS systems, due to the LMDS frequency interleaving pattern, will include cases in which the feeder uplink frequency is coincident with a portion of the LMDS signal away from the LMDS carrier.

In fact, *the interference from LMDS should be evaluated with no peaking factor, or with a peaking factor of zero dB or less.* This approach accounts for the fact that when the feeder uplink is at a frequency coincident with an LMDS carrier, it is also coincident with an LMDS guard space on an interleaved channel. For the latter case, the "peaking factor" should be minus 3 dB or even lower, in effect canceling the positive 3 dB factor.